

What is claimed is:

1. A locking device of an air-operated normally-closed valve for a gas cylinder, said gas cylinder being provided with a valve port and a valve body which  
5 opens and closes said valve port, said locking device comprising:

a housing which can be detachably attached to said valve port of said gas cylinder;

a piston assembly provided in said housing, said  
10 piston assembly being biased by a spring force to move said valve body in a direction to close said valve port when said housing is attached to said valve port;

a tapered axial member positioned coaxially with an axis of said piston assembly on an opposite side of said  
15 valve port, said tapered axial member having an annular outer tapered surface which gradually reduces in diameter thereof in a direction away from said valve port;

a lock nut which is screw-engaged with said housing to be coaxial with said tapered axial member;

20 an annular inner tapered surface formed on an inner peripheral surface of said lock nut to correspond to said annular outer tapered surface;

an intermediate cylinder member which is integral with said housing and positioned between said annular outer  
25 tapered surface and said annular inner tapered surface,

said intermediate cylinder member having at least one radial through hole; and

at least one lock piece which is inserted into said radial through hole to be freely movable therein, and  
5 contacts with said annular outer tapered surface and said annular inner tapered surface,

wherein said lock nut can press said lock piece against said annular outer tapered surface via said annular inner tapered surface to lock said piston assembly by  
10 changing an amount of screw engagement of said lock nut with said housing.

2. The locking device according to claim 1, further comprising:

a valve-opened-state indicating cylinder member  
15 which can move relative to said tapered axial member to project from said housing; and

a spring for biasing said valve-opened-state indicating cylinder member in a direction to make said valve-opened-state indicating cylinder member embedded in  
20 said housing,

wherein said valve-opened-state indicating cylinder member is pressed by said tapered axial member which moves in a direction to open said valve body to project from said housing against a spring force of said spring.

25 3. The locking device according to claim 1,

wherein said housing comprises a pressure chamber for moving said piston assembly in a valve opening direction thereof against a biasing force which biases said piston assembly in a valve closing direction thereof, wherein  
5 compressed air is applied to said valve opening pressure chamber in order to move said piston assembly in said valve opening direction.

4. The locking device according to claim 1, further comprising:

10 a valve stem which is provided independently of said piston assembly, wherein said valve stem moves in the same direction as said piston assembly and acts on said valve body in said valve port;

at least one valve stem roller member which is  
15 supported by said valve stem, and has an axis of rotation extending in a direction perpendicular to a direction of a sliding movement of said valve stem without intersecting an axis of said valve stem;

a tapered surface portion provided on an end of said  
20 piston assembly adjacent to said valve stem; and

at least one intermediate roller member mounted between said tapered surface portion of said piston assembly and said valve stem roller member, said intermediate roller member being in rolling engagement  
25 with said valve stem roller member and said tapered surface

portion and having an axis of rotation extending parallel to said axis of rotation of said valve stem roller member, wherein said tapered surface portion, said intermediate roller member and said valve stem roller member are arranged such that when said piston assembly is moved by a unit displacement toward said valve stem in order to move said valve stem toward a valve seat via said tapered surface portion, said intermediate roller member, and said valve stem roller member, said valve stem are moved by a displacement smaller than said unit displacement of said piston assembly.

5. The locking device according to claim 4, wherein said valve stem roller member comprises a pair of valve stem roller members which are arranged in a rotationally symmetrical manner with respect to said axis of said valve stem, and

wherein said intermediate roller member comprises a pair of intermediate roller members which are arranged in a rotationally symmetrical manner with respect to said axis of said valve stem.

6. The locking device according to claim 5, wherein said valve stem and said pair of valve stem roller members constitute a valve stem assembly.

7. The locking device according to claim 4, wherein said valve stem is coaxial to said piston assembly.

8. The locking device according to claim 4, wherein said tapered surface portion comprises a conical surface portion.

9. The locking device according to claim 4, wherein  
5 said tapered surface portion comprises a wedge-like surface portion having a pair of oblique flat surfaces.

10. The locking device according to claim 4, wherein said piston assembly comprises an operation shaft which extends coaxially with said valve stem,  
10 wherein one end of said operation shaft is fixed to said tapered axial member, and

wherein said tapered surface portion is formed on another end of said operation shaft.

11. The locking device according to claim 2, wherein  
15 said valve-opened-state indicating cylinder member projects outwards from an outer end of said intermediate cylinder member when said valve body is disengaged from a valve seat.

12. The locking device according to claim 1, wherein  
20 said radial through holes formed on said intermediate cylinder member comprises two radial through holes formed on radially opposite sides of said tapered axial member, and

wherein said lock piece comprises two lock pieces  
25 which are inserted into said two radial through holes,

respectively.

13. The locking device according to claim 12, wherein each of said two lock pieces is in the form of a cut-out portion of a ring member.